CURRICULUM VITAE

Name:	Marco Affronte
Date and Place of Birth:	23rd April 1961, Florence, Italy.
Status:	Married, two children. Italian citizen
Degrees awarded:	- Laurea degree *cum Laude* in Physics at University of Florence (I); 1987 - Ph.D. obtained at Ecole Polytechnique Fédérale de Lausanne (CH) in 1991. - Qualification as *Maitre de Conférence,* Condensed Matter Physics (F) 1993.
Career and Awards:	Post doc. individual fellowship at CNRS, LEPES, Grenoble (F) 1991-93 awarded within the European Marie Curie Program. *Researcher* at University of Modena (I); 1993-2002. *Associate Professor* at University of Modena (I); 2002-13 *Maitre de Conférence invité* at Univ. J. Fourier Grenoble (F) June-Aug.1995 *Maitre de Conférence invité* at Univ J. Fourier Grenoble (F) June-Aug.1997. CNR-INFM *team leader* 2006-2016 *Professeur invité* at Univ. Paris Sud Orsay (F) Feb. 2015
Current position:	**Full Professor** of Physics (SC 02/B2, SSD FIS01) at University of Modena and Reggio Emilia (UNIMORE) Italy since March. 2013.
Major Research Interests:	Quantum and critical phenomena in low dimensional systems. Quantum Technologies Nano-Magnetism, (Quantum) Spintronics Superconductivity. Development of novel & hybrid nano-devices. Graphene. Measurements in extreme conditions: low temperatures, high magnetic fields, high pressure, e.m. radiation. Spectroscopies and Microscopies.
Publication record:	**more than 210 research articles in peer reviewed journals**, including: 1 Nature Nanotech.; 1 NPJ Quantum Materials, 1 NPJ Quantum Information; 3 Scientific Reports; 10 PRL; 43 PR-B (A, Mat); 1 NanoLetter; 3 ACS Nano; 4 Adv. Funct. Mat; 4 Angew. Chem; 2 JACS; 5 APL; 10 review articles and chapters of books published under commission. 1 patent. **>6000 citations. h-index=42 (WoS)** **ORCID ID:** 0000-0001-5711-7822
Teaching and coordination tasks:	1988-1991: Assistant at EPF Lausanne (CH) 1993-2002: Researcher at School of Engineering "Ferrari" of University of Modena. Assistant to several courses of Physics. 1996 to 2002: Lecturer for Courses on Fundamentals of Physics. 2002 to date: Courses on Fundamentals of Physics. 2008-to date: Course on *Nanomagnetism, Spintronics & Quantum Techn.* 2006-2010 Coordinator of the European Doctorate in Molecular Magnetism. 2007-2011 Coordinator of PhD School on NanoSciences, UNIMORE. 2014-2019: **Director of PhD School** in Physics and Nanosciences at UNIMORE
Languages:	Italian, French, English.
present address:	University of Modena e Reggio Emilia (UNIMORE) Department of Physical, Informatics, Mathematical Sciences via G. Campi 213A; 41125 Modena Italy email: marco.affronte@unimore.it; skype: marcoaffronte

SCIENTIFIC LEADERSHIP PROFILE: *"self evaluation"*

The scientific leadership of Marco Affronte is grounded in his ability to set up and perform experiments under extreme conditions (low temperatures, high magnetic field and high pressures) and to develop novel devices combining hybrid (nano-)systems. This allows him to make risky /never-conventional choices and to lead long term projects with success. As an example, he succeeded in setting up a new state-of the-art low temperature laboratory in Modena (I), a place with no tradition in this area.

His solid background in Condensed Matter Physics allows him to explore new research fields. He has moved from superconductivity to quantum technologies passing through the study of charge transport in disorder materials, quantum critical phenomena in molecular magnets, surface science and the realization of nano-devices, always obtaining inspiration from visionary theoretical models in different areas. Yet, his main results are underpinned by unconventional experimental techniques and materials.

M.A.'s research activity was always directed to explore new concepts and to open new fields of research: in 1990, in Geneva with Prof. Ø.Fischer and J.M. Triscone, M.A. studied *YBCO/PrBCO (superconducting/insulator) multilayers* as first example of superconductivity in true 2D superconductors; in 2000 he discovered superconductivity under pressure in $CaSi_2$; in 1998-2002, with Prof. Gatteschi and R. Sessoli (Agilent Technology Prize in 2002), M.A. used unconventional techniques to study quantum and critical phenomena in low dimensional (1D- 0D) magnetic systems; in 2004 M.A. discover *giant magneto caloric effects in molecular nanomagnets*; in 2005 M.A. was one of the pioneers in proposing *molecular spins for Quantum Computation* and published seminal works on *spin entanglement* at supramolecular level; in 2010, M.A. renewed his collaboration with Dr. W. Wernsdorfer (Agilent Technology Prize in 2002) to begin a pioneering program on *Molecular Quantum Spintronics;* more recently (2015) M.A.'s group has developed hybrid circuits QED to exploit coherent coupling between microwave photons and (molecular) spins in view of full integration of these systems with superconducting and graphene-based devices. The leadership and the impact of M.A. to these fields is witnessed by his track record in key publications, grants, invited talks as briefly presented here below.

EXCURSUS OF M.A.'s SCIENTIFIC CAREER.

- The career of Marco Affronte (M.A.) started with the Laurea work (1987) on low temperatures physics at University of Genova (I) under the supervision of Prof. C. Rizzuto.
- During his PhD. thesis at E.P.F. Lausanne (CH) (1988-91) under the supervision of Prof. D. Pavuna, he collaborated with Prof. Ø. Fischer in Geneva (CH) and he made original works studying transport properties of YBCO/PrBCO multilayers and Hall effect studies on HighT_C superconductors.
- In 1992-93 he begun to perform experiments at High Magnetic Field facility in Grenoble (F).
- 1994-2002 as Researcher at University of Modena, he started collaborations with different groups, mostly in Italy and France, on different topics including the study of transport properties in granular materials, oxides, rare earth alloys and silicides, basing his experimental activity in external laboratories.
- 1997 M.A. patented, with other authors, and worked on a *hallow cathode electron gun* for the applications in metallurgy and he led an industrial project to the realization of one prototype.

2000 Start of independent experimental activity.

- 1999-2002 Thanks to some national grants (mainly PRA and FIRB), M.A. set up a new low temperature laboratory. Considering the lack of infrastructures, support and tradition in low temperature Physics in Modena, the choice of the instrumentation was risky but M.A. set up a top class multifunctional cryomagnetic system, working continuously up to date. At present, this low-T laboratory is recognized as one of the top and most active in Italy and it comprises a 9T-vector magnet, a low temperature Scanning Hall probe microscope, two ^{3}He cryostats with access to MW, microwave electronics, probe station. The lab is also equipped with liquefier for recovering exhausted He (2015).
- 2000 M. Affronte set up an apparatus for resistivity measurements under high pressure, the first one in Italy.
- 2002 M. Affronte was one of the promoters of the "S3" National Research Centre *on nanoStructures and bio Systems at the Surface,* now *Institute of Nanoscience of CNR (*http://www.nano.cnr.it/*)*

Content and Impact of Major Scientific Contributions.

Superconductivity was the first field of research where M.A. obtained novel results, including :

- Studies of the Hall effect in YBCO/PrBCO multilayers and the upper critical field of copper free cubic perovkites (PRB 43,13, 11484 1991)

- In 2000 M.A. discovered superconductivity in $CaSi_2$ at 14K under pressure (PRB 61, 3800, 2000 and PRB 62, 11392 2000), an important result since it anticipated the discovery of superconductivity in AlB_2-type materials such as MgB_2 and since this is the highest T_c reported for silicides so far.
- In 2006 M.A. reported direct evidences of two-gap superconductivity in MgB_2 by specific heat measurements, a result that is still largely quoted and discussed in the community (PRL 96, 077003, 2006).
- M.A. found evidences for an unprecedented case of spin reorientation in the new family of superconducting oxy-pnictides (PRB 214404, 2009. Phys. Rev. Res. 2, 023387, 2020. Phys. Rev. Mat. 4, 114803, 2020).
- 2014-to now: development of high-Tc YBCO superconducting planar resonators for circuits QED experiments up to 80K and in high magnetic fields (APL 106, 184101, 2015).

Molecular Magnetism.

In 1998, M.A. started collaboration with the group of Prof. D. Gatteschi and R. Sessoli (Agilent technology Prize in 2002) on Molecular Magnetism and he focused on the study of the thermodynamic properties of these materials. M.A. initially obtained novel results in this field by using ultra-low temperature calorimetry and high field torque magnetometry. M.A. applied calorimetry in a rather unconventional way to study different **critical and quantum phenomena** on molecular magnets like:

- the chiral phase transition in Gd-radical chains [PRL 100, 057203 (2008)].
- direct evidence of level repulsion in ferric wheels [PRL 88 167201 (2002)].
- M.A. was also the first to propose and apply torque magnetometry to study the magnetic anisotropy of molecular magnets and his early works became as reference paper in the literature [PRB 60, 12177 (1999); *Angew Chem.* 15, 2264-2266 (1999)].
- In 2004, M.A. considered high spin molecular magnets with low anisotropy and he suggested exploiting these features for **magnetic refrigeration**. His seminal works on Cr_7Cd and Fe_{14}, Mn_{10} are references in the field (APL 84 3468, 2004 and APL 87, 072504, 2005).
- M.A. was asked to write a review paper on magnetothermal properties of molecular magnets [J. *Mat. Chem*. 16, 2534 –2549 (2006)]. Recent achievement along this line of frustrated molecular spin system is in *NPJ Quantum Materials* 3, 1, 10, (2018)
- In 2006, M.A. and collaborators reported an odd case of slow relaxation of magnetization in molecular Ni_{10} and Co_{10} supertetrahedral proposing a new mechanism of phonon trapping. (PRL97**,** 207201, 2006).

Surface Science.

Original results have been obtained by M.A. and collaborators on:

- Grafting molecular nanomagnets on different substrates by exploiting different functionalizations. Combined Scanning Probes techniques and XPS, XAS analysis have been successfully used to analysed results. Review on subject was recently published as chapter of a book ("Thin Layers of Molecular Magnets", A. Cornia, D. R. Talham, M. Affronte, in *Molecular Magnetic Materials: Concepts and Applications*, Wiley-VCH Germany, 2017)
- Use of X-ray magnetic dichroism as local probe to study magnetic excitations in molecular nanomagnets [PRB **77**, 014402 (2008); PRB 79, 144419 (2009); PRB 79, 224430 (2009)]
- Combined lithographic and deposition methods have been used to set novel protocols for positioning magnetic nanoparticles on patterned surfaces (*SMALL* 4, No. 12, 2240, 2008)
- M.A. used X-ray Magnetic dichroism to demonstrate that giant magneto caloric effect is an intrinsic properties of individual molecules dispersed on surface. (*Advanced Materials* 25, 2816–2820 (2013), *Adv. Funct.Mat* 24, 30, 4782, 2014*)*
- combined theoretical-experimental study on the interplay between molecule-substrate (*ACSnano* 9353, 2016. *Scientific Report* 6, 21740, 2016).

Realization of nano- (molecular scale-) devices.

- Nano-Hall probes of different semiconducting and metallic materials with high magnetic flux sensitivity have been realized by Focus Ion Beam milling (Nanotechnology 17, 2105 (2006))
- An innovative **Scanning Hall Probe Microscope** have been successfully used to study patterned magnetic surfaces (*SMALL* 4, 12, 2240, 2008).
- Silicon (SiN) membranes have been developed as ultra sensitive calorimeters.
- **Graphene** based devices have been realized (Carbon 104, 112, 2016) and used as magnetic flux magnetometers and even to fabricate *molecular spin valve* (***Nanoletters*** 11, 2634, 2011). Further graphene based architectures were used as platform to build hybrid nano-nanodevices for optoelectronics (*J. Phys. Chem. C,* (2017), 121 (19), 10620. J. of Phys. Chem. C 2019, 123, 43,

26490.

- **Molecular tunnel junctions:** using electro-burning, the M.A.'s group has developed method to fabricated molecular junctions with graphene electrodes (*Dalton Trans,* 2016, **45**, 16570. *Molecular Architectonics,* Ed. T. Ogawa, Springer p.165 DOI 978-3-319-57096-9_8).
- **Quantum Dots based on semiconducting nanowires:** realisation of gated QDs from heterostructured InAs nanowire allowed the study of photon assisted tunnelling [Sci. Rep. 9, 19523 (2019)] that recently lead M.A.'s team to propose these systems as microwave detectors [**Sensors** 2020, 20, 4010]

Quantum Physics and Quantum Technologies.

- In 2005 M.A. published three key papers proposing **molecular spin clusters (Cr_7Ni) as suitable candidate to encode qubits**. These works brought the attention of the community on molecular spin clusters with low spin and demonstrated that Cr_7Ni molecule fulfils the requirements for QIP, thus paving the way for the implementation of a *molecular* quantum computer.
- Following initial ideas, M.A. and collaborators in Italy and Manchester published an elegant joint experimental and theoretical work on **spin entanglement in supramolecular systems** (*Nature Nanotechnologies*, 2009) and another one showing direct quantification of this quantum effect in such molecular systems (PRL 104, 037203 2010).
- Based on the above mentioned scientific results, M.A. proposed & lead a EU FET Open project (*MolSpinQIP, http://www.molspinqip.org/* 2008-11) grouping top scientists in the field (Wernsdorfer, Loss, Ardavan, Winpenny, Gatteschi, Coronado). This project anticipated most of the key ideas in the field and it turns out to be one of the most successful EU-FET project in terms of impact (publications, citations etc) of the EU-FP7.
- **Molecular Quantum Spintronics:** M.A. was the coordinator of a pioneer EU project ("*MoQuaS"* http://www.moquas.eu/ *2013-16*) aiming at exploring quantum effects on individual molecular spins embedded in electronic circuits/junctions. Worth mentioning as a significant result, the study of back-action (dephasing) due to quantum measurement on single molecular spin embedded in electrical circuit that has been recently considered in a combined experimental and theoretical work (*Phys Rev Letters* 118, 257701, 2017).
- M.A.'s group is now developing **hybrid circuits QED** to couple microwave photons in superconducting YBCO resonators (APL 106, 184101,2015) with molecular spins (PRA **93**, 063855 2016, Dalton Trans. 45, 16596, 2016). The team has recently demonstrated that high cooperativity regime can be achieved by using selected *molecular* spin ensembles and microwave photons in a QED circuit experiments (*Scientific Reports* 7, 13096, 2017. *Adv. Quantum Technol.* 1900101, 2019. *Adv. in Physics X* 3:1, 1435305). recent pulsed MW experiments allow to demonstrate storage end retrieval of MW pulses within molecular spins (NPJ Quantum Information 6: 68, 2020)
- **Microwave photon detectors**: M.A. recently proposed and he is now team leader of the EU FET open project *Supergalax* for development of superconducting detectors devoted to the search of light dark matter particles.

Top 10 publications, as senior author:

1. *Molecular Engineering of antiferromagnetic rings for quantum computation*. F. Troiani, A. Ghirri, M. Affronte, S. Carretta, P. Santini, G. Amoretti, S. Piligkos, G. Timco, R.E.P. Winpenny **Phys. Rev. Lett.** 94, 207208 (2005). [citations>230]
2. *Engineering coupling between molecular spin cluster qubits. by coordination chemistry* G. A. Timco,, S. Carretta,, F. Troiani,, F. Tuna,, R. J. Pritchard,, E. J. L. McInnes,, A. Ghirri, A. Candini, P. Santini, G. Amoretti, M. Affronte and Richard E. P. Winpenny. ***Nature Nanotechnology*** *4, 173 (2009)* [citations >300]
3. *Entanglement in supramolecular spin systems of two weakly coupled antiferromagnetic rings (purple Cr_7Ni)* A. Candini, G. Lorusso, F. Troiani, A. Ghirri, S. Carretta, P. Santini, G. Amoretti, C. Muryn, F. Tuna, G. Timco, E. J. L. McInnes, R. E. P. Winpenny, W. Wernsdorfer, and M. Affronte ***Phys. Rev. Lett.*** *104, 037203* (2010). [citations>85]
4. *A ferromagnetic mixed-valent Mn supertetrahedron: towards low-temperature magnetic refrigeration* M. Manoli, R. D. L. Johnstone, S. Parsons, M. Murrie, M. Affronte, M. Evangelisti and E. K. Brechin ***Angew Chem.*** Int. Ed. 46, 4456 (2007) [citations >120]
5. *Observation of the Crossover from Two-Gap to Single-Gap Superconductivity through Specific Heat Measurements in Neutron Irradiated MgB_2* M.Putti, M.Affronte, C.Ferdeghini, P.Manfrinetti, C.Tarantini, E.Lehmann ***Phys Rev Lett.*** 96, 077003 (2006). [citations>70]
6. *Graphene Spintronic Devices with Molecular Nanomagnets.* Andrea Candini, Svetlana Klyatskaya, Mario Ruben, Wolfgang Wernsdorfer and Marco Affronte ***Nanoletters*** 11, 2634–2639 (2011) [citations>250]
7. *A case study of anisotropic exchange interaction: Ln(III) bis-(phthalocyanine)s molecular nanomagnets on Ni substrate.* A. Candini, D. Klar, S. Marocchi, V. Corradini, R. Biagi, V. de Renzi, U. del Pennino, F. Troiani, V. Bellini, S. Klyatskaya, M. Ruben, K. Kummer, N. B. Brookes, H. Wende, M. Affronte ***Scientific Report*** *6,* 21740 (2016)
8. *Landau-Zener Transition in a Continuously Measured Single-Molecule Spin Transistor* F. Troiani, S. Thiele, F. Balestro, C. Godfrain, W. Wernsdorfer, S. Klyatskaya, M. Ruben, M.Affronte ***Phys Rev Lett.*** 118, 257701 (2017) (citation 12)
9. *High Spin Cycles: Topping the Spin Record for a Single Molecule verging on Quantum Criticality A. Baniodeh, N. Magnani, Y. Lan, Christopher E. Anson, J. Richter, M. Affronte, J. Schnack, A. K. Powell NPJ Quantum Materials 3, 1, 10, 2018 (citations: 37)*
10. *Storage and retrieval of microwave pulses with Molecular Spin Ensembles* C. Bonizzoni, A. Ghirri, F. Santanni, M. Atzori, L. Sorace, R. Sessoli, and M. Affronte **NPJ Quantum Information** 6: 68 (2020)

Review articles - published under commission:

- *AF molecular rings for quantum computation.* M. Affronte, F. Troiani, A. Ghirri, S. Carretta, P. Santini, G. Amoretti , S. Piligkos, G. Timco , R.E.P. Winpenny. Polyhedron 24, 2562 (2005).
- *Molecular routes for spin cluster qubits,* M. Affronte, F. Troiani, A. Ghirri, S. Carretta, P. Santini, V. Corradini, C. Muryn, G. Timco and R. E. Winpenny Dalton Transactions 2810-2817, 23 (2006)
- *Magnetothermal properties of molecule-based materials* M. Evangelisti, F. Luis, L.J. de Jong and M. Affronte, J. of Mat. Chem. 16, 2534 – 2549 (2006).
- *Molecular nanoMagnets for information technologies.* M. Affronte. J. Mater. Chem., 19, 1731 (2009).
- *Spin Entanglement in supramolecular structures.* F. Troiani, V. Bellini, A. Candini, G. Lorusso and M. Affronte *NanoTechnology* 21, 274009 (2010).
- *Molecular Spins for Quantum Information Technologies.* F. Troiani, M. Affronte Chemical Society Reviews 40, 3119-3129 (2011) [citations >300]
- *Molecular Spins in the Context of Quantum Technologies* A. Ghirri, A. Candini, M. Affronte Magnetochemistry 3(1), 12 (2017).
- *Coherent coupling of molecular spins with microwave photons in planar superconducting resonators.* C. Bonizzoni, A. Ghirri, M. Affronte Advances in Physics X 3:1, 1435305 (2018)
- *Towards Quantum Sensing with Molecular Spins* F. Troiani, A. Ghirri, M. G. A. Paris , C. Bonizzoni, M. Affronte, *Journal of Magnetism and Magnetic Materials* 491 (2019) 165534;
- *Microwave Photon Detectors Based on Semiconducting Double Quantum Dots*, A. Ghirri, S. Cornia, M. Affronte **Sensors** 20, 4010 (2020)

Chapters of books:

- *Potentialities of Molecular Nanomagnets for Information Technologies.* M. Affronte and F. Troiani, chapter in the book *Molecular Magnets p. 249-273*, NanoScience and Technology, J. Bartolomé et al. (eds.) DOI 10.1007/978-3-642-40609-6_10, © Springer-Verlag Berlin Heidelberg (2014).
- *Quantum Computation with Molecular Nanomagnets: achivements, challenges and new trends.* A. Ghirri, F. Troiani and M. Affronte *in* Molecular Nanomagnets and Related Phenomena - Structure and Bonding Ed. Song Gao *Springer* Volume 164, 2014, pp 383-430 DOI: 10.1007/430_2014_145
- *Thin Layers of Molecular Magnets,* A. Cornia, D. R. Talham, M. Affronte, in *Molecular Magnetic Materials: Concepts and Applications* (eds B. Sieklucka, D. Pinkowicz), Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany, **2017**.
- *Addressing single molecular spin with graphene based nano-architectures.* A.Candini, S. Lumetti, F. Balestro, W. Wernsdorfer, M. Affronte in Molecular Architechtonics, Ed. Ogawa Takuji (2017) p.165, ISBN 978-3-319-57095-2. DOI 978-3-319-57096-9_8, © 2017

Oral presentations: more than 50 at international meetings in the last 10 years, including:

2019: invited talk at workshop Carrier Doping In Two-Dimensional Layered Materials, Napoli 4-5 Nov.
2019: invited talk at SPICE workshop on Molecular electro- opto spintronics, Mainz (D), 15-18Oct.
2019: Invited talk at Joint European Magnetic Symposia, Uppsala SW, 26-30 August.
2019: keynote presentation at 6th AWEST, June 16-20, in Awaji Island, Hyogo,Japan
2019: Invited Talk at 5th International Workshop on Novel Magnetism and Multifunctional Materials Hanoi Vietnam Jan 9th-12th
2018: Invited Talk at ECMols Workshop, Peniscula (SP) Oct. 20-24
2018: Invited lecture at SPIN+X Summer School on Molecular Spintronics, Mainz (D) Oct 8-12
2018: Invited talk at International Conference on Molecular based Material, Rio e Janeiro 3-6 Sept. (BR)
2017: keynote presentation at 5th AWEST, June 18-21, in Awaji Island, Hyogo,Japan
2016: Invited Talks at Int. Workshop on 4th International Workshop on Novel Magnetic and Multifunctional Materials in Paris, France 4-8 July 2016
2015: 3 invited talks at Pacifichem Int Conf. , Honolulu (USA) 15-20 Dec.
2015: invited talk at International Workshop on Molecular Architectonics, Shiretoko JP, 3-6 August.
2015: invited talk at International Conference on Magnetism Barcelona 5-10 July 2015.
2014: invited talk Functionalized molecule-based magnetic materials, 24, 27 November Bielefeld Germany.
2014: invited talk at Wilhelm und Else Heraeus-Seminar "Functional metalorganics and hybrids" 17 - 19 November, 2014 — Physikzentrum Bad Honnef, Germany
2014: invited talk at SpinMol Conference, Ascona , Switzerland 26-30 October.
2014: invited talk at International Conference on Molecule based materials (St. Peterburg (RU) July
2014: invited talk at EMRS Lille (F), May 2014.
2013: invited talk at European Conference of Molecule-based Material (Karlsruhe) Oct 2013
2013: keynote presentation at 1st AWEST, June 16-18, 2013 in Awaji Island, Hyogo,Japan
2013: invited talk at International Workshop on Development of Functionalized Molecule-based Magnetic Materials**,** Sendai, Japan. Feb 2013
2012: invited talk at bilateral workshop on Nanomagnetism and Spintronics, Camberra (AUS)
2012: invited talk at FunMOL workshop Bonn (D), Oct 2012
2012: invited talk at Inter. Workshop on Novel Nanomagnetic and Multifunctional Materials (Seoul, June).
2012: 2 invited talks at Intern. Conference of Superconductivity and Magnetism, Instanbul (May)
2011: Invited talk at SEST Conference (Sendai, Japan Nov. 2011).
2011: Invited talk at workshop on "Open shell materials" (Awaji, Japan Nov. 2011).
2010: Invited talk at Joint European Magnetic Symposia JEMS 2010 Kraków, (PL) August 23 - 28, 2010.
2010: Invited talk at International Conference "Trends in Spintronics and Nanomagnetism" Lecce (I) May
2010: Invited talk on *"Spin Entanglement in supramolecular systems"* at Workshop on Molecular spintronics, Copenhagen DK, January 2010.
2009: Lecture on *Spin Entanglement* at European School on Molecular Nanoscience (ESMOLNA), *Benidorm SP, October 2009.*
2009: *Plenary Talk* at the conference *NanoSpain,* Zaragoza (SP) March 2009.
2008: *Keynote oral presentation* at the international Conference ICMM, Firenze I, Sept. 2008.
2008: *Invited talk* at *51th Fujihara Seminar* Tomakomai, Jp Aug. 2008.
2008: *Invited talk* at workshop on *Applications of Molecular Magnets* (Huesca SP, Aug. 2008).
2008: *Training lecture* on *Molecular Antiferromagnets* at European School on Molecular Nanoscience (ESMOLNA), *Gandia, SP October 2008*

MANAGEMENT AND FUNDING ID.

M.A. has developed his management experiences at 3 different levels:

1. **as team leader of CNR Institute of Nanoscience** (http://www.nano.cnr.it/)
   - 2006-2016 "*Responsabile di Commessa", i.e.* team leader of the group "NanoMagnetism". This team comprises *ca*. 15 researchers including: theoreticians, surface scientists besides M.A.'s group working on low temperature experiments. Besides administration, this activity includes coordination of experimental and theoretical activity and guidance of young researchers (see below).

2. **Coordination of PhD Schools.**

2006 - 2010 M.A. coordinated the European Doctorate in Molecular Magnetism (EDMM), which was part of the European Network of Excellence *MAGMANet*. This initiative has led to: 1) the recognition of credits and exchange of teachers formalized cooperation agreements between a dozen European universities, 2) the delivery of European Diploma to students of different nationalities and 3) the delivery of 15 scholarships to students in the different European universities. Currently the EDMM is an integral part of the European Institute on Molecular Magnetism (www.eimm.eu/index.php), a consortium formed by fifteen European University.

2014-2019 **M.A. was Director of the PhD School in Physics and Nanosciences** (http://www.nano-phdschool.unimore.it/site/home.html) of UNIMORE. This PhD School has 24 students (8 new students each year for 3-years thesis work) and a *Collegium* (Steering Committee) of 20 Professors from Physics and Chemistry Dpt. All activities are carried out in English and major Director's tasks include the organization of lectures & seminars, student mentoring and examination, coordination with directors of other PhD Schools and with the Rector of UNIMORE, partnerships with other international Universities and Enterprises.

3. **coordination /participation to InterNational projects.**

In the last 20 years M.A. has established very fruitful network of collaborations with leading scientists, recognised at international level, and working in different fields ranging from Quantum Science, Superconductivity, to Molecular (Nano-)Magnetism and Spintronics. These collaborations are testified by the list of publications with different collaborators worldwide and also by the projects run at International level (Europe, US, Japan, Australia) as listed here below:

- Team Leader of the European STREP project H2020-FET-OPEN *"Supergalax"* (total 2.4M€) 2020-22
- International project *Quantum Properties of Molecular Nanomagnets,* supported by U.S. AOARD-17IOA040 Three years funding for 165KUS$ (2017-20).
- Team leader of the PRIN project *"Quantum Coherence in Nanostructures of Molecular Spin Qubits"* (105K€), 2017-2020.
- Coordinator of the European STREP project FP7-ICT FET-PROACTIVE on *"Molecular Quantum Spintronics"*. Three years funding for total 2.0 M€, (2013-2016).
- Coordinator of the European STREP project FP7-ICT FET-OPEN on *"Molecular Spin Clusters for Quantum Information Processing" MolSpinQIP.* Three years funding for total 2.0 M€, (2008-2011).
- International project *Quantum Properties of Molecular Nanomagnets,* supported by U.S. AOARD-13-4029 Three years funding for 80000US$ (2013-15).
- Co-investigator of Australian Research Council grant: *Spin detection and control in molecular nanomagnets at surfaces* (PI: Dr. A. Soncini). AUS$637.000 (2015-18)
- Coordinator of Research Project funded by CRM Bank Foundation on *Molecular Spintronics* worth 105K€ for two years; start date December 2009.
- Leader of Unit in National PRIN (2008) project on *"Spin Dynamics and quantum effect in molecular nanomagnets"*. 70K€ for two years.
- Leader of the CNR-INFM Node of EC Network of Excellence *"MagmaNet"* with fourteen other European groups. The grant (10.7 MEuros in total, *ca.*1M€ to CNR) was for four years to aid integration of research in "Molecular Magnetism". 2005-2009
- Leader of Unit in National PRIN (2006-2009) project on *"Spin Dynamics and quantum effect in molecular nanomagnets"*. 90K€ for two years.
- Leader of the CNR-INFM Node European of Framework VI Research Training *Network "Quantum Effects in Molecular Magnets"*. 200K€ over four years. 2004-2008.

- Leader of Unit "*Nanoorganization of hybrid moleculer systems" (FIRB project)*. 211K€ for 3 yr.
- Leader of Unit for *Mesoscopic Molecular Magnets "MESMAG" (INFM, Project of Research Activities 1999-2001);* 350K€.
- Leader of Unit for *"Very low temperature Physics"* (FRA-INFM, 2001); 120K€.
- Leader of Unit for *"Applications of superconductivity"* (CNR project, 2000-2002); 90K€
- Leader of Unit for French-Italian *Galileo* program (1997-98) and (1999-2000); 40K€.
- Leader of Unit for *"High T_c superconductivity"* (CNR project 1997); 30K€.

International Recognition and roles.
M.A. management experience is also grounded on his participation to different *Steering Committees* and *evaluation Panels* of European Agencies as listed here below:

- Member of the Physics 2 Evaluation Panel of the Academy of Finland (2019, 2020)
- Member of the 24° Evaluation Panel on "Micro and nano technologies for ICT" of the French Agencies ANR, (2017, 2018, 2019). This Panel has to select best projects over 260 proposals in a two-steps process to allocate ˜12M€ budget available from French ANR Agency on this area for 2017.
- M.A. was involved in the ICT FET Pilot Flagship CA *Guardian Angels* (2014) as representative of the Italian CNR and now in the preparation of the Eu Flagship Initiative on *Quantum Technologies*.
- Reviewer for EU projects: ICT FET (2009-2012); EU COST (2017); EU NMP (2010); ERC (2009-2016).
- Reviewer for International Agencies including: FOM (NL); EPSRC (UK); US; Poland; Latvia; Chile
- Reviewer for National FIRB, PRIN, SIR projects (2011-to date)
- Member of the Evaluation Panel Batch 6, ICT FET Open. This Panel selected the best EU projects in the ICT area Bruxelles (July 2009).
- Member of the Steering Committee of the European Institute of Molecular Magnetism (2008-, www.eimm.eu/)
- Member of the Governing Board of the EC NoE MAGMANet (2005-09)
- Member of the Governing Board of the EC Marie Curie network QUEMOLNA (2004-08)

Further MA's experience in managing scientific events was acquired in the **Organisation of International conferences:**

- Co-Organizer of the First European International Meeting on Molecular Magnetism, Tomar, Portugal 2006;
- Co-Organizer of the E-MRS symposium R "DCM4-II: Design, characterization and modeling of molecule-based magnetic materials", Strasbourg, France 2007;
- Co-organizer of the JEMS'08 symposium Magnetic Model Compounds, Molecular magnets and Organic Spintronics, Dublin from September the 14th-19th 2008;
- Co-organizer of the *11th International Conference on Molecule-based Magnets*, Florence 21 to 24 September 2008.
- Member of the scientific panel of the FET11 Conferences (Budapest May, 2011) organized by the ICT European Commission.
- **Chairman** of the workshop on *Entanglement in Solid State Systems,* Lecce (I) Sept. 2011.
- **Chairman** of the Simposium on *Atomic and Molecular Scale Systems and Devices*, EMRS Fall Meeeting , Warsaw Sept. 2016

APPLICATIVE RESEARCH.

- 1999 M.A. proposed and worked on "*realization of a prototype of electron gun for industrial applications"* in collaboration with local enterprise. This activity, funded by 40K€, lead to the realisation and test of prototype device and to a Italian Patent.
- 2008 M.A. with a PhD student implemented the technique of *micro-Hall magnetometers*, based on 2D heterostructures, in a commercial cryomagnetic system for measuring small magnetic crystals in different conditions, leading to an important collaboration with Quantum Design industry (see *application note* 1099-205, http://www.qdusa.com/resources/index.html). Similar technology was used to develop and test a Hall scanning microscope in collaboration with *Nanomagnetics (*https://www.nanomagnetics-inst.com/ *)*
- 2015. M.A. coordinated a large scale initiative of UNIMORE on *"Nano-Molecular and Information Technologies for Personal Health Care"* which allowed to contact a dozen of enterprises in the region working on this area. These contacts are now mainly used for training young researchers.

TEACHING.

from Jan. 1988 to Dec. 1991: Assistant at the Swiss Federal Institute of Technology Lausanne (CH).
The Swiss Federal Institute of Technology Lausanne (EPFL) is, with ETH Zurich the most important Institution for high education in Switzerland. During the four years at EPFL, M.A. had two teaching tasks:
- lab assistant for students in the second year of study, i.e. experiences of mechanics, thermodynamics and optics. This activity comprised ~ 250 teaching hours per year, split into two semesters.
- supervisor of three Diploma works. The diploma work was carried out in two steps: a first stage during the last semester of study, and a second phase of measurements and interpretation of data for a period of four months. Some results of these Diploma works have been published on international journals and two students have continued their studies and now cover positions respectively professor at the University of Paris VI and EPFL (*vide infra*).

1993-2001: as Researcher at the Faculty of Engineering *"Enzo Ferrari"* of the University of Modena. This School has several links with the prestigious automobile factory *Ferrari* which is located close by. M.A. has accomplished the following tasks:
- exercises and examinations of the courses of General Physics General Physics 1 and 2 of the Faculty of Engineering of Modena. M.A. has dealt with two courses, "Informatics" (~ 250 students enrolled in the first year) and the other one on "Mechanics and Materials" (~ 200 students enrolled in the first year).
Since 1996 M.A. taught the following courses in full:
AA1996-97 General Physics (Mechanics) for the Diploma Course in Mechanical Engineering.
AA1997-98 General Physics (Mechanics) for the Master of Science in Mechanical Engineering and Materials Engineering. Semester with ~ 200 students.
AA1999-2001 General Physics (Mechanics) for the Master of Science in Materials Engineering and Mechanical Engineering. Semester with ~ 200 students.

2002-2012: as Associate Professor at School of Engineering *Enzo Ferrari* of the University of Modena, M.A. has accomplished the following tasks:
2002 - 2013 Course in Physics (Fundamentals of Mechanics) for degree courses in Electronics and Telecommunications Engineering. Three-month course (9CFU) with ~ 100 students.
2002 - 2013 Course on Physics Laboratory for degree courses in Electronics and Telecommunications Engineering. Three-month course with ~ 100 students.

since 2008: Course on (nano)Magnetism and Spintronics for Master students in Physics. This course combines fundamentals of Magnetisms with advanced spintronics. The first part of the course includes basic concepts of quantum magnetism, theory of angular/magnetic momenta, fundamentals on magnetic interactions, long range order in magnetic materials as well as elements of experimental techniques to measure magnetic properties of materials. The second part of the course includes description of magnetism of single domain particles, basics of magnetic recording, giant magnetoresistance, spin transfer torque and description of spintronic devices. The course also includes lectures on molecular magnetism and notions of quantum computation with spins. Fundamentals of quantum technologies (quantum sensing with NV center and superconductor qubits) have been recently added to this course.

since 2013, as Full Professor Corse of General Physics (Fundamentals of Electro Magnetism) for classes of physicists, mathematicians and electrical engineers (total 150 students /year)

Teaching Style. M.A. offered a program of General Physics as much as possible related to the degree course. For example, for the course of Mechanical Engineering, M.A. lingered particularly on constraining forces, rigid body and the functioning of machines. For the course of Electronic Engineering, M.A. focused particularly on the dynamics of a harmonic oscillator and the fundamental characteristics of the wave phenomena. There are many examples and references taken from personal experience gained in many years of scientific research, in particular by thermodynamics.
In 2002 M.A. started a new Laboratory course for Engineers (3 credits). The course included laboratory experiments carried out by students and it was particularly appreciated by them and by the Faculty, given the importance of practical experience and the difficulty in managing classes of 50-100 students.

The management of examinations, even in critical periods of overcrowding, comprises written test as well as oral tests (~ 30min per student). For the Laboratory, M.A. requires written reports, particularly important in the first year.

MENTORING

M.A. was/is supervisor of 18 Laurea works for the degree course in Physics and Materials Engineering.

Since 2000, M.A. has supervised of 11 PhD thesis works at the University of Modena and RE, and he was in the Jury of 4 commissions in Grenoble (F) and in Germany. The fields of study of these theses ranging from the development of instrumentation to theoretical physics passing from the experimental study of different materials.

Ability to inspire and guide younger researchers.
Since 2000, M.A. was able to group an exceptional team of brilliant young Italian researchers with outstanding track records and he motivated them to intriguing challenges and new fields of research.
Much work needs to be devoted to generate interest and this requires time to be devoted to listen and learn from students and young researchers. Enthusiasm and ideas of young researchers keep research alive but achievable objectives need to be fixed and the scheduling of work must be tight. Individual initiatives should be balanced by team work. All these aspects are well present in the M.A. management of human resources. Examples of how M.A. motivated young researchers are briefly mentioned here below.

Two students, A. Shuckla and D. Martin, from E.P.F.L. (CH) who made diploma work with M.A. are now professors at Université de Paris VI P.&M. Curie and at E.P.F.L. respectively.
Dr. M. Evangelisti came in Modena from Leiden University with a background in low temperature Physics. M.A. suggested to focus on magnetocaloric effect on molecular nanomagnets, a topics that M.E. has successfully developed. He is now researcher of CSIC in Zaragoza (SP).
Dr. A. Candini developed Hall probe magnetometry and graphene nano devices under the supervision M.A. .He obtained one National prize and individual FIRB grant. He is now researcher at CNR.
Dr. A. Ghirri developed a cryogenic Scannging Hall Probe Microscope during his PhD thesis under the supervision of M.A. He obtained 3 National awards for his scientific activities in 2004, 2005, 2008 and one national FIRB grant for young researchers. He is now CNR researcher developing hybrid QED circuits.
Dr. F. Cinti made a theoretical PhD. work with M.A. Recently they published a combined experimental and theoretical work on chiral phase transitions. He was Post Doc at University of Edmonton (Canada) and at University of Stellenbosh (South Africa), now researcher at Univ. of Florence (IT).
Dr. V. Corradini, CNR researcher with a background in surface science, started to work on molecular magnets on surfaces collaborating with M.A.
Dr. F. Troiani is a brilliant theoretician with background in quantum computation on quantum optics. In 2005 he was motivated to look at molecular spin clusters as candidates for QIP by M.A.. He is now the theoretical *engine* of the CNR group on quantum computation.
Dr. V. Bellini is a specialist on DFT calculations. He started to work on molecular magnets producing original works on AF Cr_8 rings.
Dr. C. Bonizzoni is developing circuit QED instrumentation and experiments as PhD student and now postDoc in M.A. group.
Key collaboration with theoreticians in Parma developing model based on spin Hamiltonian approach was established around 2003 and it is a unique example of synergy between experimental and theoretical activities. The collaboration with Dr. S. Carretta (O. Kahn Prize 2011) boosted most of the experimental works and led to an impressive number of novel results.

OUTREACH.

- M.A. has made a major effort for spreading scientific knowledge to the widest and disparate audience. M.A. is indeed used to make presentations to high schools on different topics ranging from cosmology to nanotechnology.
- In 2006 M.A. collaborated to the preparation and the presentation of the photographic exhibition "Blow-up: images from the Nanoword" (http://www.s3.infm.it/blowup/index.html), a unique collection of images taken with different microscopes at the nanoscale and elaborated by a professional photographer (L. Covi). The exhibition appeared on the national and international press (see *Nature* **455**, 714, 2007 for instance). He then collaborated to bring this exhibition to Paris (2008) and other Italian cities.
- M.A. made also presentations in meetings with general public: *"Quattro serate con la Fisica"* Modena June 2007, http://www.physicscom.unimore.it/index.php?page=4serate); *"ScientiaeMunus"* Parma Feb. 2008 (http://scientiaemunus.provincia.parma.it/).
- Interviews with M. A. have been published in National journals like il *Sole 24 Ore* (10 Oct. 2007 and 15 Nov. 2007) and Il Resto del Carlino (12 Feb. 2008).
- M.A. wrote an article for dissemination of his research activity through the Italian scientific community: *Molecular Architectures for hybrid nanodevices,* A. Candini, V. Corradini, A. Ghirri, M. Affronte. vol 32, n.5-6, 2016, p. 42-52 de Il Nuovo Saggiatore (ISSN 0393-4578; online version: 1827-6148)

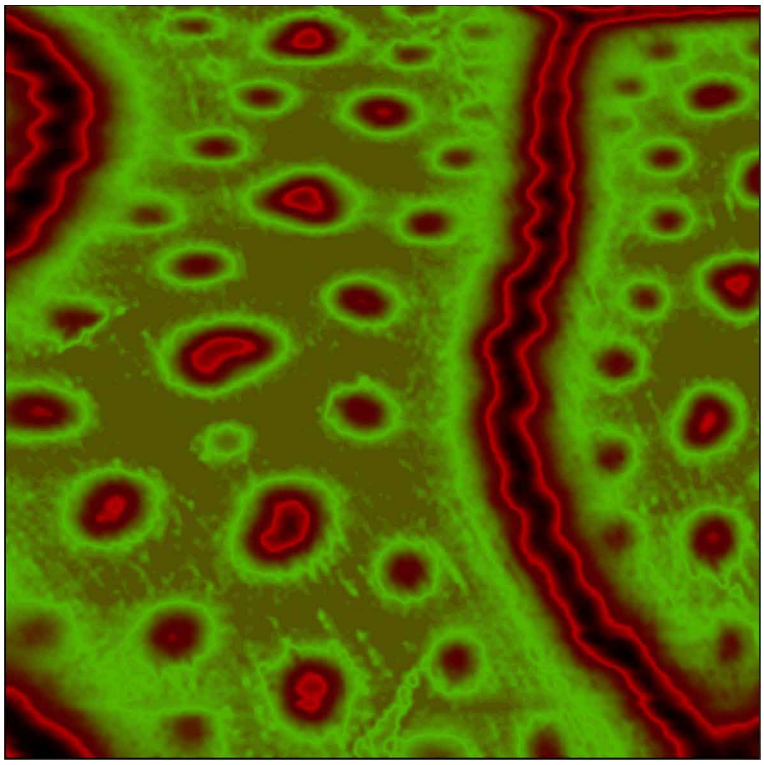

image of magnetic domains on ferrite taken with Scanning Hall Microscope and selected for Image Gallery and book"Blow-up" (A. Ghirri and M. Affronte).